Claims

1. (amended) A method for selectively reducing, inactivating or destroying an agent in a heat-sensitive material, the method comprising:

a) heating the heat-sensitive material at a rate of at least 50 degrees C per second to a pre-selected temperature of at least 60 degrees C to provide a heated liquid material;

b) cooling the heated liquid material at a rate of greater than 100 degrees C per second;

c) circulating the heat-sensitive material, at a flow rate of greater than 100 liters per hour, during the heating and the cooling;

wherein the reducing or inactivating of the agent occurs while maintaining desirable properties of the heat-sensitive material.

2. (amended) The method of claim 1 wherein the heating further comprises exposing the heat-sensitive material to microwave energy, the microwave energy comprising a frequency of at least 1000 MHz.

3. (amended) The method of claim 1 wherein the heating further comprises exposing the heat-sensitive material to microwave energy from a microwave generator, the microwave energy comprising a frequency of at least 1000 MHz and the microwave generator has a power capacity of at least 10 kW.

4. (amended) The method of claim 1 wherein cooling comprises passing the heated liquid material through a plurality of heat exchangers, said plurality of heat exchangers comprising a tube in shell heat exchanger and a plate heat exchanger, and wherein said rate comprises a cooling rate of between 200 and 600 degrees C per second.

5. (amended) A method for reducing, inactivating or destroying an agent in a heat-sensitive material, the method comprising:

a) circulating the heat-sensitive material, at a flow rate of greater than 100 liters per hour,

b) heating the heat-sensitive material through the employment of a microwave generator producing microwave energy having a frequency of at least 1000 MHz and a power capacity of at least 10 kW, for a pre-selected time sufficient to heat the heat-sensitive material at a rate of at least 50 degrees C per second to a pre-selected temperature of at least 60 degrees C, to provide a heated liquid material; and

c) cooling the heat-sensitive material at a cooling rate of at least 100 degrees C per second,

wherein the reducing or inactivating of the agent occurs while maintaining desirable properties of the heat-sensitive material.

6 – 7 (withdrawn)

8. (amended) The method of claim 5 wherein the heating comprises a heating rate of between about 100 degrees per second to about 450 degrees C per second.

9 -10 (withdrawn)

11. (amended) The method of claim 5 wherein the microwave generator produces microwaves having a frequency of 2450 +/- 50 MHz.

12 – 14 (withdrawn)

15. (amended) The method of claim 5 wherein the circulating further comprises a flow rate in the range of 100 liters per hour to 500 liters per hour.

16. (amended) The method of claim 5 wherein the cooling comprises flowing the heat-sensitive material through a heat exchanger.

17. (amended) The method of claim 5 wherein the cooling comprises flowing the heat-sensitive material through a tube and shell heat exchanger.

18. (amended) The method of claim 5 wherein the cooling comprises flowing the heat-sensitive fluid through a plurality of heat exchangers.

19. The method of claim 18 wherein one of the plurality of heat exchangers comprises a tube and shell heat exchanger and another of the plurality of heat exchangers comprises a plate heat exchanger.

20. The method of claim 18 further comprising flowing the heat-sensitive material first through a tube and shell heat exchanger and second through a plate heat exchanger.

21. The method of claim 17 wherein the tube and shell heat exchanger comprises a jacketed tube and shell, the jacket comprising a secondary coolant chamber surrounding a primary coolant chamber.

22. The method of 21 wherein the primary and secondary chambers are flowably connected and wherein the coolant in the secondary chamber is received from the primary chamber.

23-32 (withdrawn)

33. (amended) The method of claim 5 wherein the circulating further comprises pumping the heat-sensitive material through tubing of internal diameter of not more than 1 inch.

34. (amended) The method of claim 5 wherein the circulating further comprises pumping the heat-sensitive material through tubing of internal diameter of between one-tenth of an inch to one-half an inch.

35 – 41 (withdrawn)

42. The method of claim 5 wherein the agent comprises a virus.

43. (amended) The method of claim 5 wherein the agent comprises a microorganism.

44. (amended) The method of claim 5 wherein the heat-sensitive material comprises a protein and wherein maintaining the desirable properties of the heat-sensitive material comprises reducing the activity of the protein by not more than 90%.

45. (amended) The method of claim 5 wherein the heat-sensitive material comprises a protein and wherein maintaining the desirable properties of the heat-sensitive material comprises reducing the activity of the protein by not more than 75%.

46. (amended) The method of claim 5 wherein the heat-sensitive material comprises a protein and wherein maintaining the desirable properties of the heat-sensitive material comprises reducing the activity of the protein by not more than 50%.

47-50 (withdrawn)

51. (amended) A system for reducing, inactivating or destroying an agent in a heat-sensitive fluid material, the system comprising:

a) a source of microwave energy producing microwaves with a frequency of greater than 1000 MHz, said source of microwave energy comprising a power supply of greater than 10 kW;

b) a flow path for providing a flow stream of the heat-sensitive fluid material, the flow stream having a flow rate of greater than 100 L/hr;

c) a waveguide in microwave contact with the source of microwave energy, the waveguide adapted to receive the flow path for the flow stream within the waveguide;

d) a cooler adapted to receive the flow path for the flow stream after the flow stream exits the waveguide and capable of cooling the flow stream;

e) a control module for controlling components of the system,

wherein the control module controls the flow of heat sensitive material through the flow path and controls the application of microwave energy to the heat sensitive material.

52. The system of claim 51 wherein the power supply is contained within a power supply module located remotely from the control module and controlled by the control module.

53. (withdrawn)

54. (amended) The system of claim 51, further comprising a utility module, the utility module located remotely from the control module and controlled by the control module and comprising a source of cooling fluid for the system.

55. (withdrawn)

56. (amended) The system of claim 54 further comprising a heat exchanger for heating the heat-sensitive material in the flow stream prior to the flow stream entering the waveguide and wherein the utility module comprises a source of heating fluid for the heat exchanger.

57. (withdrawn)

58. (amended) The system of claim 51, wherein the cooler comprises a plurality of heat exchangers.

59-60 (withdrawn)

61. (amended) The system of claim 58 wherein one of said heat exchangers comprises a tube and shell heat exchanger and wherein said tube and shell heat exchanger comprises a flow path surrounded by a chamber containing cooling fluid.

62. (amended) The system of claim 58 wherein one of the heat exchangers comprises a jacketed tube and shell heat exchanger, the jacket comprising a secondary chamber containing cooling fluid surrounding a primary chamber containing cooling fluid .

63. (withdrawn)

64. (amended) The system of claim 58 wherein one of the plurality of heat exchangers comprises a plate heat exchanger and another comprises a jacketed tube and shell heat exchanger.

65. (amended) The system of claim 51 wherein the cooler comprises a plurality of heat exchangers and wherein a first heat exchanger cools at a rate of at least 100 degrees C per second and a second heat exchanger cools at a rate of not greater than 100 degrees C per second.

66. The system of claim 51 wherein the heat-sensitive material is heated at a rate of at least 100 degrees C per second.

67. The system of claim 51 wherein the microwave generator produces microwave energy having a frequency of 2450 MHz +/- 50 MHz.

68. (amended) The system of claim 67 wherein the microwave generator has a power capacity of between 10 kW and 30 kW.

69 -74 (withdrawn)

75. The system of claim 51, wherein the flow path for the flow stream within the waveguide is secured to a removable plate.

76. – 96 (withdrawn)